Space Weather Technical Forecast

Issued on Tuesday, 13 December 2022 at 13:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares (R1-R2; Minor-Moderate radio blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low over the past 24 hours, with a maximum C3 flare peaking at 12/1509 UTC from the vicinity of one of the smaller groups in the southeast, AR3166.
This is just one of eleven sunspot regions on the visible disc, with the 24-hour period seeing a rapidly developing bipolar region in the northeast. The largest region is AR3153 near the southwest limb, with the most magnetically complex AR3165 in the southwest. No regions are showing any significant activity or magnetic complexity, however. No Earth-directed Coronal Mass Ejections (CMEs) have been seen in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by DSCOVR, were mostly slightly elevated. The wind speed varied between 440-510 km/s, easing after 13/0800 UTC to be between 380-420 km/s. The solar wind density was mostly average, dropping to below average after 13/0800 UTC. The IMF, Bt, was weak at 7nT or below, with the north-south component, Bz, varying weakly between +/-6nT. The phi angle was towards the Sun (negative) throughout. Geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at Background levels. High energy electron flux (greater than 2 MeV), as observed by GOES16, has been at mostly Background levels. The associated 24-hour fluence was on a slight rising trend, well below Active (1e8 integrated pfu). Observed fluence at 13/0000UTC was 5.14e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is most likely to be Low with occasional C-class flares, but there is also a chance of isolated M-class flares. These are currently most likely from AR3153, AR3165 or the newly developed region in the northeast.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs feature in the current forecast, although with the number of sunspots on the visible disc, some weak transient influence cannot be ruled out. A weak high speed stream (HSS) may arise from a tenuous northwestern coronal hole, although with STEREO-A not showing any signs of this, it begins to look as though any HSS is increasingly unlikely.
All considered, geomagnetic activity is likely to be Quiet to Unsettled, with a slight chance of isolated Active intervals on Days 1 or 2 (13-14 Dec) if we do see any HSS influence. Predominantly Quiet geomagnetic activity is expected thereafter.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to remain at background levels throughout, with a daily slight chance of seeing S1+ levels if any significant flares occur.
High energy electron flux (greater than 2 MeV) is currently at background to moderate flux

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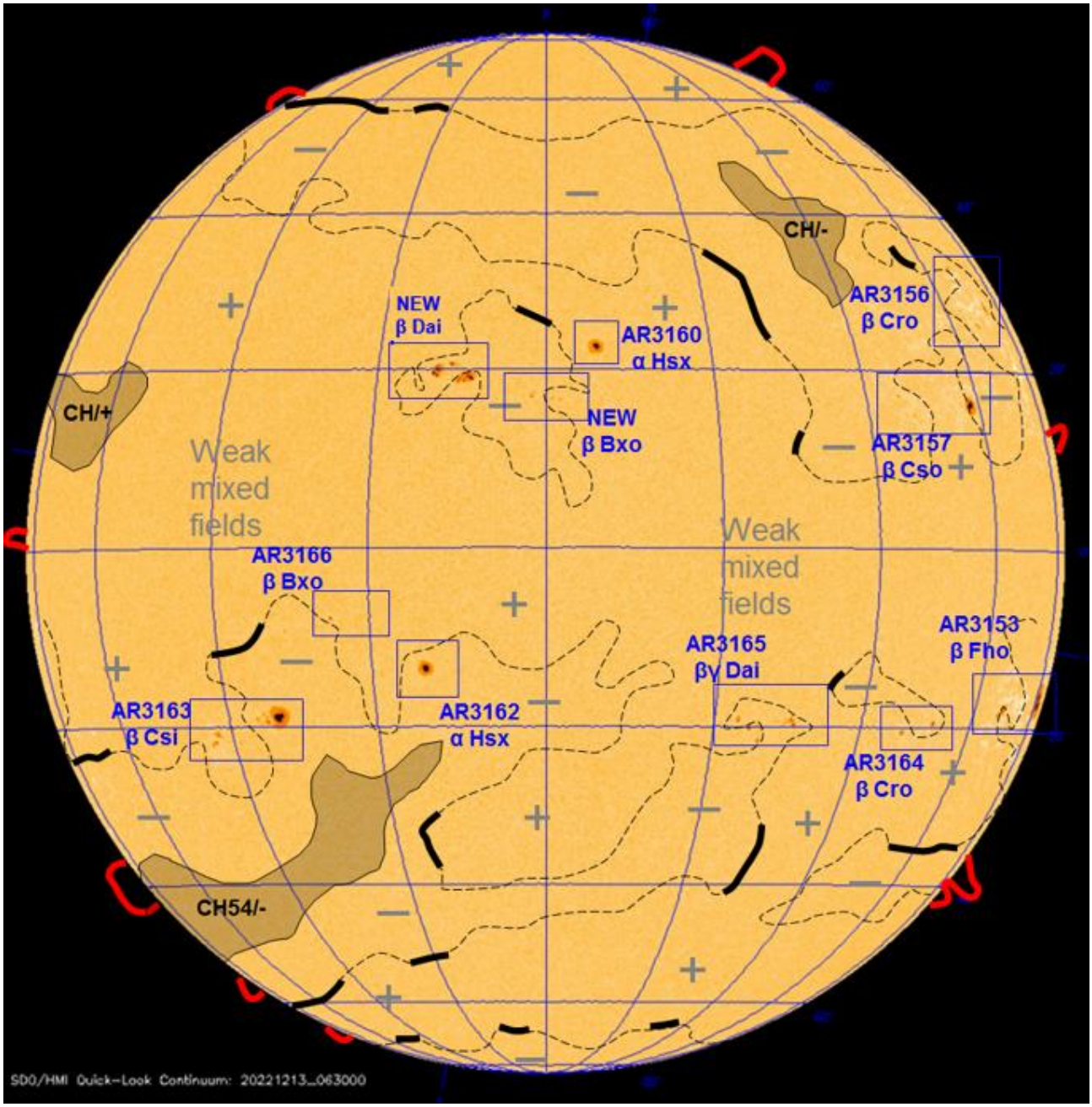
levels, which will probably be maintained through the period. There is a slight chance of an increase to reach high levels at the diurnal maxima, but this is looking increasingly unlikely. The 24-hour integrated electron fluence is forecast to remain below the Active (1e8 integrated pfu) threshold, with any increase now likely to be modest and stay below Active levels.

Figure 1. Solar Analysis Valid 13/0600 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs feature in the current forecast, although with the number of sunspots on the visible disc, some weak transient influence cannot be ruled out.

A weak high speed stream (HSS) may arise from a tenuous northwestern coronal hole that was present on the last rotation, but delivered almost no discernible effect at Earth. MOSWOC Enlil model output has dealt with this feature in a very erratic manner, with some suggestions of a HSS reaching 500km/s, but with an onset time varying by 24 hours. There is not yet any sign of a HSS at STEREO-A, and it begins to look as though any HSS is increasingly unlikely.

All considered, geomagnetic activity is likely to be Quiet to Unsettled, with a slight chance of isolated Active intervals on Days 1 or 2 (13-14 Dec) if we do see any HSS influence. Predominantly Quiet geomagnetic activity is expected thereafter.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
*	*	*	*	*	*	*

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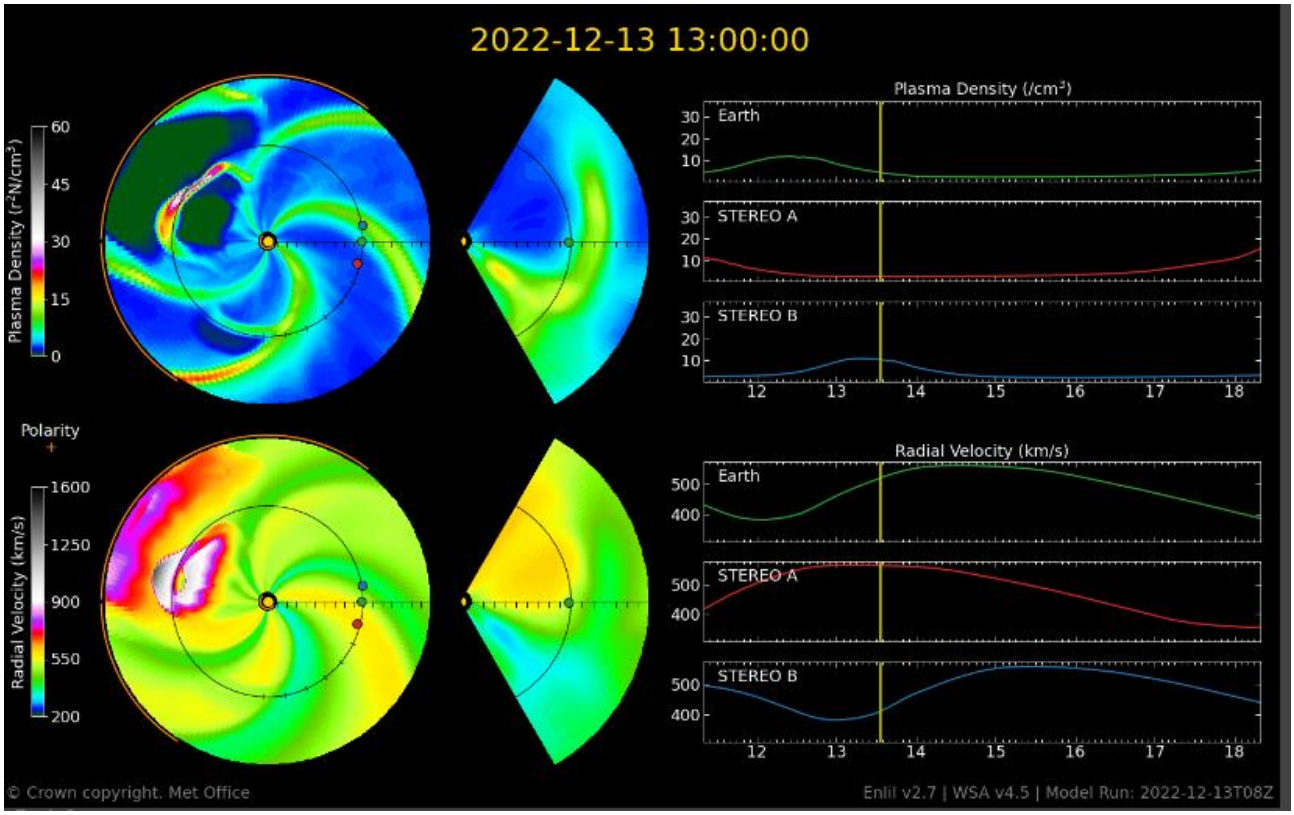
Figure 2: MOSWOC Enlil model, which is suggesting a HSS near 500 km/s into Day 2 (14 Dec). This is probably overdone, with slightly elevated wind speeds near 400 km/s more likely.



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Radio Blackouts - X-Ray Flares:

There are currently eleven sunspot regions on the Earth facing disc, although the majority are long-term stable residents with little in the way of magnetic complexity. AR3153 (Fho/Beta) is the largest region on the disc and is now near the southeast limb, making it difficult to classify due to the viewing angle. It has showed little change in its transit across the disc, however. AR3165 (Dai/Beta-Gamma) is the most magnetically complex region, although it may be two separate regions very close together. There is also a new region in the northeast (Dai/Beta) which has developed rapidly in the last 24 hours, but currently has a simple magnetic structure. The other regions are all fairly simple with little complexity. There appears to be a possible new region rotating onto the southeast limb, although no spots are visible yet.

Overall, activity is less than would be suggested by the raw probabilities from the various sunspot groups, with C-class flares expected and a chance of M-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is most likely to remain at background levels throughout. There remains a daily Slight Chance of S1 or greater levels at GEO if any significant flares were to occur. The 5% risk is mainly made up of a contribution of risk from AR3153, AR3165, and the newly developed region in the northeast.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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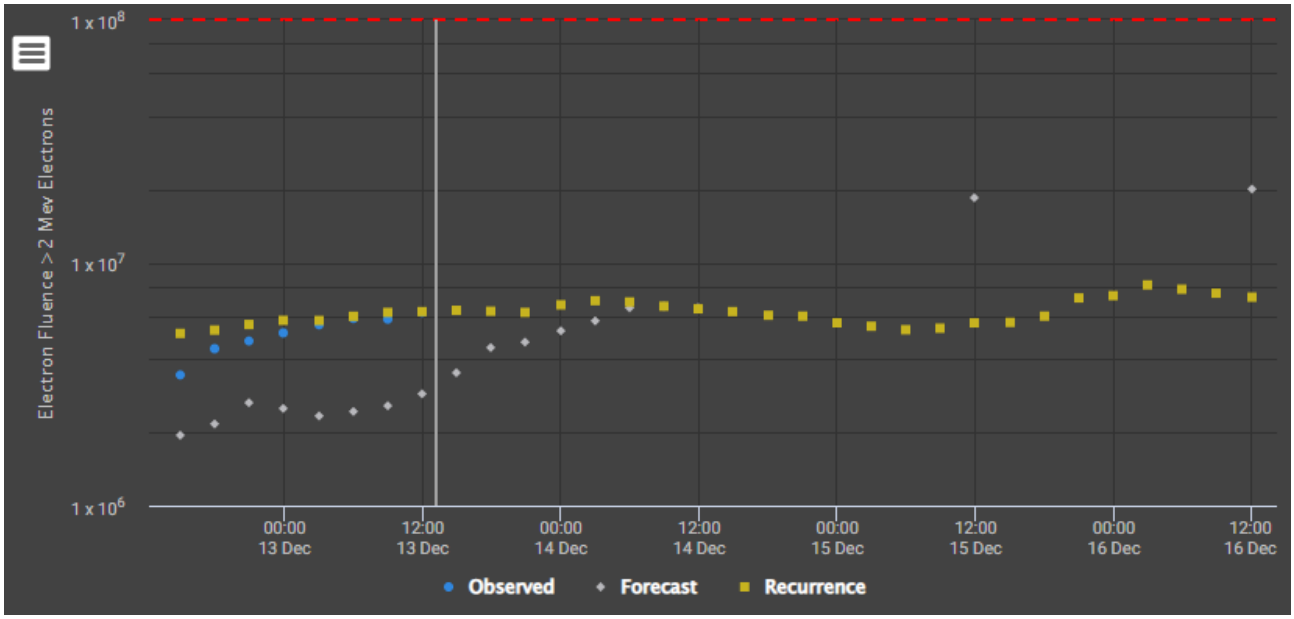
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2 MeV) is only just reaching moderate levels at times. The currently observed background to moderate flux levels will probably be maintained through the period. There is a slight chance of an increase to reach high levels at the diurnal maxima if we see a HSS from the small northwestern coronal hole, but this is looking increasingly unlikely.

The 24-hour integrated electron fluence is forecast to remain below the Active (1e8 integrated pfu) threshold, with any increase now looking less likely than earlier. If any increase occurs it is likely to be modest and stay below Active levels. MOSWOC REFM is forecasting a slight rise below Active and this seems like good guidance, with reasonable confidence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: MOSWOC REFM showing a slight rise in electron fluence, but below the Active (1e8 integrated pfu) threshold. This seems like good guidance.



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